THE IMPACT OF ETHANOL DRIVEN CORN PRICE ON THE COW-CALF INDUSTRY

by

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ABSTRACT

After remaining stable for several decades, corn price has recently had unprecedented price increases and volatility. United States Department of Agriculture (USDA) predicts an average corn price of $5.80 per bushel for 2008, which is 232% of its 28-year (1980-2007) average price of $2.50. The record increase in corn price was the result of increased starch-based ethanol production associated with increased energy costs, and other factors such as a declining value in the United States dollar, and increased global commodity demand. High corn prices have impacted the profitability of the livestock feeding industry. It was less clear how the record high corn prices would affect the cow-calf industry since corn is not a significant input for cow-calf enterprises. This study quantified the relationship between cow-calf profitability and corn price. Because feed costs for a cow-calf producer are among the highest variable costs for the operation, both grazing and non-grazing feed costs were estimated as a function of corn price. Models were estimated to determine if a relationship between corn price and Returns Over Variable Costs (ROVC) at the cow-calf level could be identified. Corn price from 1978-2007 explained none of the variability in grass grazing rental rate, however when the projected 2008 corn price was included in the analysis, corn price explained 10% of the variation in grass grazing rates. Year (linear time trend) and corn price from 1978-2008 explained 88% of historical grass grazing rental rate variability, 71% of alfalfa price variability, and 63% of other hay price variability in Kansas. These results suggest that the new corn market paradigm likely will increase the relationship between corn price and feed costs at the cow-calf level. Several models were evaluated using bulk diesel fuel price, feeder calf price, corn price, alfalfa price, other hay price, and grass grazing rental rate to estimate Kansas cow-calf producer ROVC. Models that included diesel fuel price, feeder calf price, grazing rent, and one of the harvested feeds (corn, alfalfa, or other hay) price explained 90-91% of the variability in ROVC. Models that included diesel fuel price, feeder calf price, and either grazing rent or corn price explained less of the variability in ROVC; using grazing rent explained 89% and using corn price explained 79%. Including grass grazing rental rate along with corn price, feeder calf price, and bulk diesel fuel price improved the model's ability to predict ROVC, explaining

91% of the variability. While cow-calf producers might use very little corn directly in their operations, this research shows that corn price is an important determinant of cow-calf production returns, and corn price can be used by producers to plan for future rising costs in order to maximize returns.

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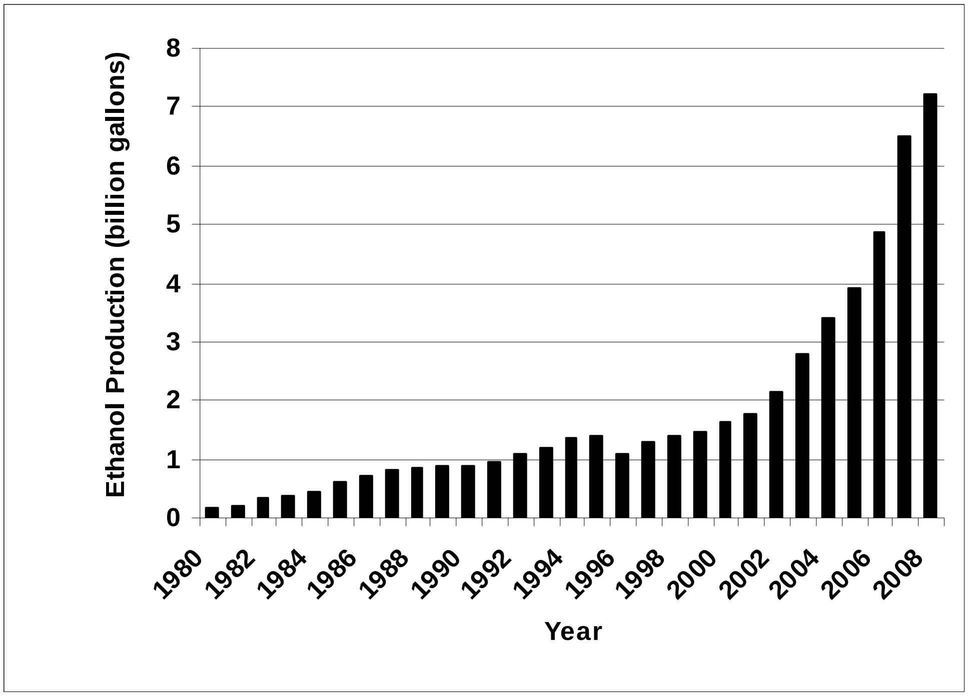
CHAPTER I: INTRODUCTION

1.1 Ethanol Production in the United States

Ethanol production in the United States has increased dramatically in the last few years as a result of rising petroleum prices and an interest in U.S. energy independence. Recent government mandates coupled with numerous other federal, state, and local policies have been enacted to encourage the construction of ethanol plants and have fostered unprecedented growth in ethanol production (Bryant and Outlaw, 2006). Figure 1.1 illustrates this dramatic growth of U.S. ethanol production, increasing from 175 million gallons in 1980 to a predicted 7.23 billion gallons in 2008 (Dhuyvetter, Kastens, and Schroeder, 2008). As of the start of 2008, 134 ethanol biorefineries were producing ethanol with 77 plants undergoing expansion or currently under construction for an increase in production capacity of 6.21 billion gallons of ethanol per year, which if all plants and projects were completed, would produce 13.44 billion gallons of ethanol per year (RFA, 2008). Due to current technology, the vast majority of ethanol presently produced in the U.S. comes from a starch feedstock, most of which is corn. According to the September 2008 USDA World Agricultural Supply and Demand Estimates, U.S. ethanol production will use 3.0 billion bushels between September 2007 and August 2008, and further predicts 4.0 billion bushels will be used for ethanol production in the 2008/09 marketing year (WASDE, 2008). The Renewable Fuels Standard Act passed in 2005 mandated that 7.5 billion gallons of ethanol be produced by 2012. The Energy Independence and Security Act (EISA) passed in December 2007 amended the Renewable Fuels Standard Act, mandating 9 billion gallons be produced in 2008, 15 billion gallons produced by 2015, and 36 billion gallons produced by 2022 (RFA, 2008). The EISA called for 15 billion gallons of ethanol to be produced using starch-based feedstock, and the remaining 21 billion gallons of ethanol to be produced using cellulosic feedstock. The 15 billion gallons of starch-based ethanol would require 5.35 billion bushels of corn using current technology, which produces approximately 2.8 gallons of ethanol for every one bushel of corn (RFA, 2008). This would indicate that the ethanol industry will have to increase production capacity even more in order to fulfill the mandate.

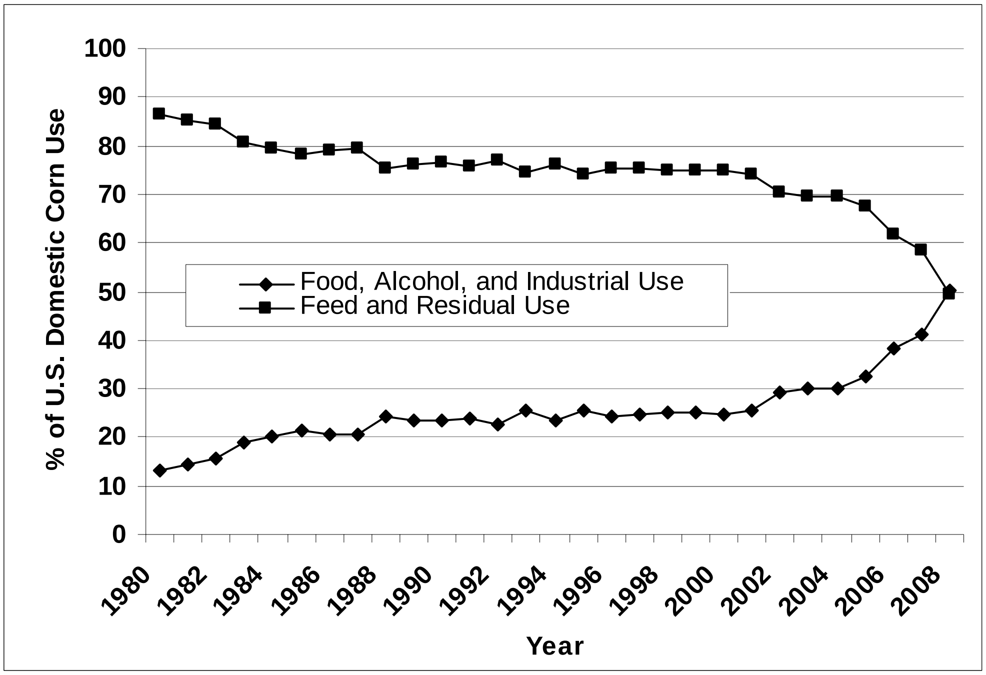
Figure 1.1 U.S. Ethanol Production, 1980-2008 (2008 forecast).



1.2 The Impact of Ethanol on Corn Prices

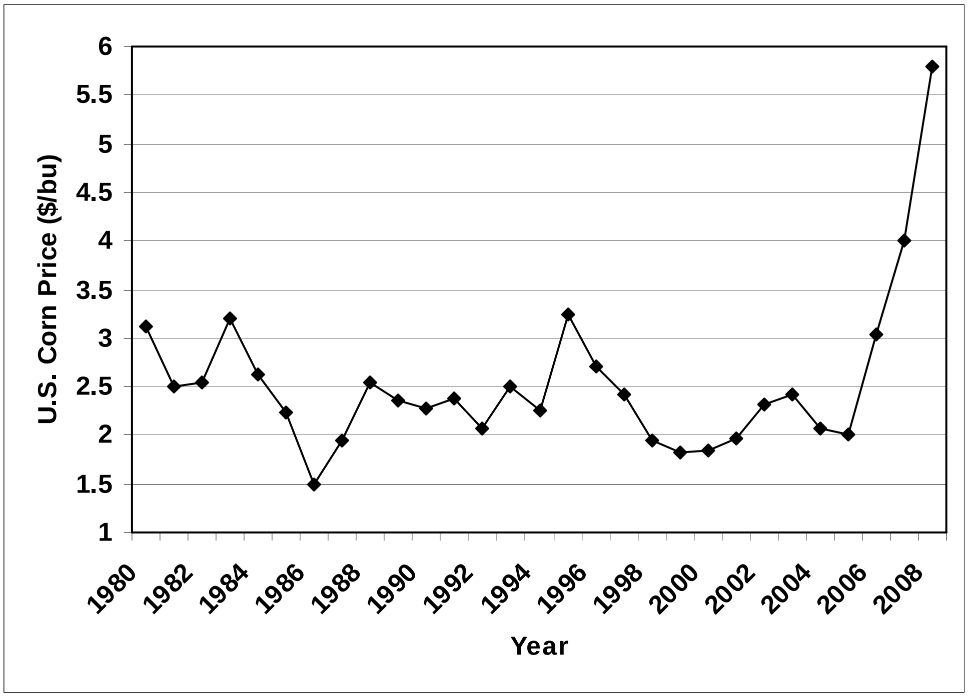
In 2004, ethanol accounted for 12% of total U.S. corn use, increasing to 14% in 2005 and 19% in 2006 (Collins, 2008). As of August 2008, the United States Department of Agriculture estimated a domestic corn crop of 12.3 billion bushels for 2008, the second largest in U.S. history (NASS, 2008). The potential increased production capacity of proposed new and expanded ethanol plants in 2008 would produce 13.44 billion gallons, and would use 39% of the U.S. corn crop to produce ethanol. The Energy Independence and Security Act which calls for 15 billion gallons by 2015 would use 44% of the U.S. corn crop to produce ethanol, if crop yields are not substantially increased from the 2008 level. Currently, U.S. domestic corn use is divided equally among use for feed/residual and food/alcohol/industrial use, a measurable shift from 1980 when 86% of the U.S. corn crop was used for feed/residual and 14% was used for food/alcohol/industrial purposes (Figure 1.2).

Figure 1.2 United States Domestic Corn Use, 1980-2008.



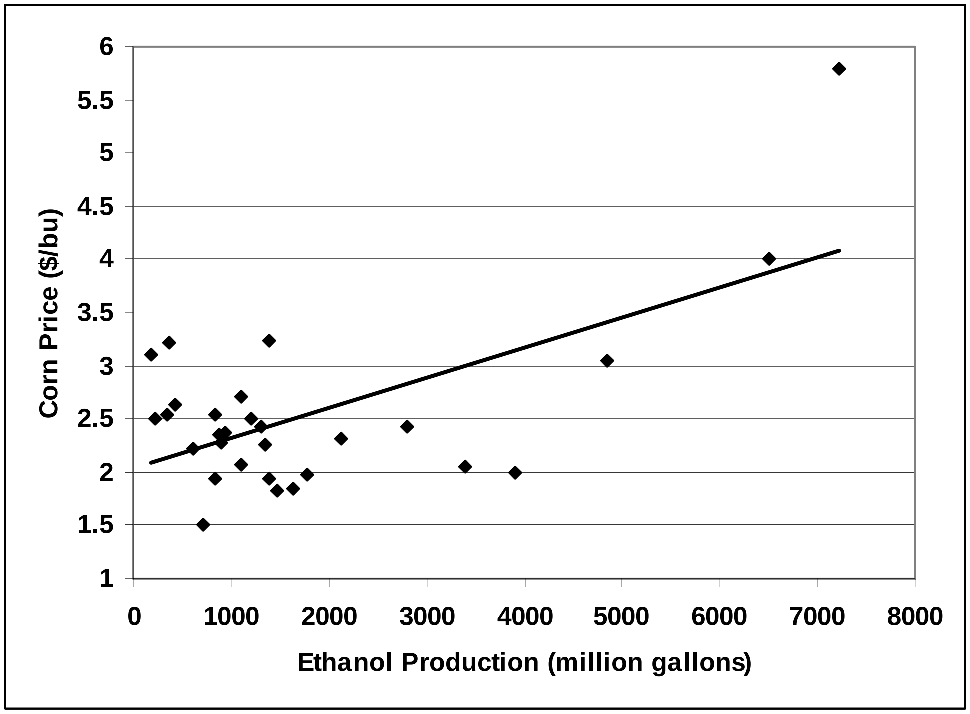
Between 1980 and 2008 corn price rarely exceeded \$3.00 per bushel, having done so only three times during this time period (Figure 1.3). Prior to 2005 corn price never exceeded \$3.00 for more than one marketing year. Between September 2006 and August 2007, producers received an average corn price of \$3.03 per bushel, which was a substantial increase from the previous time period which averaged \$2.09 per bushel (Informa, 2007). Regionally, producers might have seen an even greater price increase based on the number 2 yellow corn price in Kansas City, which averaged \$1.98 per bushel between September 2005 and August 2006, and increased to an average of \$3.42 per bushel between September 2006 and August 2007 (ERS, 2008a). United States farm-level prices maintained strength through 2007, averaging \$4.35 per bushel for the year. In June of 2008, USDA forecast the average farm-level price for the 2008/2009 crop marketing year to be \$5.80 per bushel (WASDE, 2008).

Figure 1.3 Historical U.S. Corn Prices, 1980-2008 (2008 price is USDA forecast).



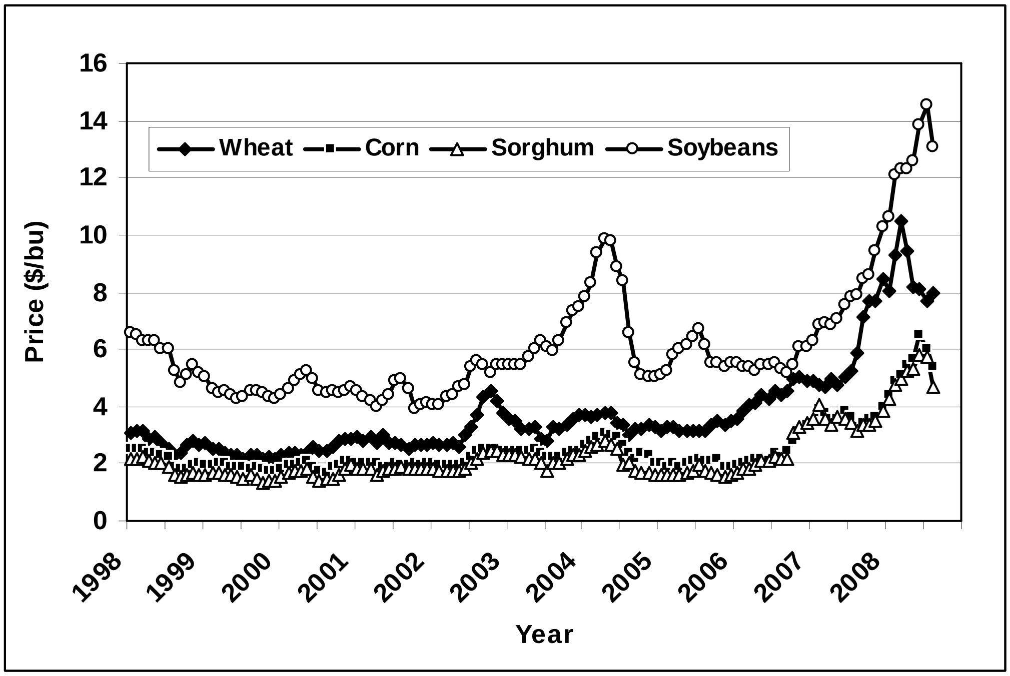
The demand for corn in ethanol production is very inelastic and is more inelastic than other uses of corn, such as feed use and exports (Westcott, 2007). This inelasticity stems, in part, from federal tax incentives for production and blending of ethanol, and an import tariff effectively insulating domestic ethanol production from world market competition. During the period 1980-2005, U.S. production of ethanol explained 12% of the variation in corn price. When data from 2006-2008 are added, ethanol production explains 37% of the variation in corn price (Figure 1.4). Ethanol's inelastic demand, along with favorable exchange rates for U.S. corn exports coupled with increased global demand, regional droughts around the world, and high energy costs have impacted corn prices (Figures 1.3 and 1.4). Future expansions of ethanol production might continue to impact the price of corn as the competition for domestic corn among the different industries increases.

Figure 1.4 Relationship Between Corn Price and Ethanol Production, 1980-2008 (2008 price is USDA forecast, 2008 ethanol production forecast).



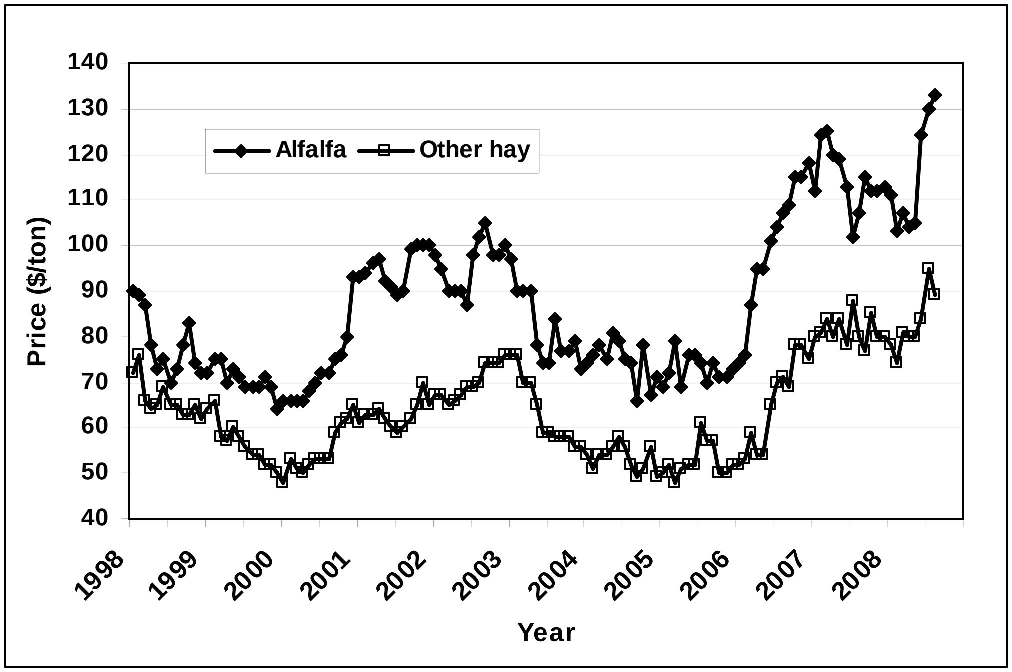
The recent increase in ethanol production not only impacted corn price, but other crop prices as well, as the competition for crop acreage increases. The price of other feed grains increased between 1998 and 2008 (Figure 1.5). Many supply and demand factors have contributed to these grain price increases besides ethanol production, including the weak U.S. dollar, increased global demand, regional droughts around the world, and high energy costs. In the past, livestock producers substituted other feed grains if one type increased in price relative to others, making price spikes for one commodity less disruptive to livestock enterprises. Cattle feeders were previously able to adjust to high corn prices and maintain profits by substituting corn with other feed grains in the diet and adjusting the weight at which feeder cattle were put on concentrate diets (Anderson and Trapp, 2000a, 2000b). However, because corn price has remained high, and the price of other feed ingredients have increased along with corn price, cow-calf producers and cattle feeders have not been able to substitute corn with cheaper grain or forage alternatives. The result has been challenging for producers to manage rising feed costs.

Figure 1.5 Kansas Monthly Grain Prices, 1998-2008, Kansas Agriculture Statistics Service.



The increase in the feed grain market has also affected the demand for pasture and grazed or harvested forage crops. The price of alfalfa and other forages increased between 1998 and 2008 (Figure 1.6). Alfalfa and other forages are major components of the cow-calf production feed expense. The increase in forage prices was the result of drought that occurred across the U.S., increased demand as cattle feeders look at alternative feed resources to put gain on cattle at a lower cost than feed grains, high energy costs that add expense to production and transportation, as well as possible competition for acres with other crops. Historically, cattle producers could add efficient gain by grazing winter wheat in the central Great Plains. Grazing rates for wheat have also increased along with the price of wheat since farmers are less inclined to graze wheat in a dual-purpose system (both graze and harvest wheat for grain) in light of high grain and fertilizer prices, which have also made wheat graze-out options less attractive for cattle producers (Haley, 2008).

Figure 1.6 Kansas Monthly Hay Prices, 1998-2008, Kansas Agriculture Statistics Service.



An uptrend in commodity prices will increase the value of land (Dhuyvetter and Kastens, 2007). In the last decade non-agricultural demand for land has had a greater impact on increasing land value than crop prices, which resulted in land prices increasing at a faster rate than land rental rates. The 160-200% increase in corn and other grain prices compared to their long-term average price indicates a substantial increase will likely follow in land rental rates, and lead to even greater increases in land prices. Data from 1950 to 2006 indicate that a 1% change in crop price translates into a 0.99% change in land value and a 0.71% change in land rent (Dhuyvetter and Kastens, 2007). At the USDA forecasted corn price of $5.80 per bushel for 2008, corn is 232% of the average price of $2.50 per bushel reported by Kansas Agricultural Statistics for the 1980 to 2007 time period. Using historical price trends, this 232% increase in corn price would equate to a 230% increase in land value and a 165% increase in land rental rate above the average 1980-2007 values. This increase in land value and rental rate is coming at a time when grain producers are experiencing both high commodity and input prices, and when livestock producers are experiencing average commodity prices and high input prices. The rental rate of grazing land increased at a much faster rate in 2007 and 2008 than what was observed in the last decade (Figure 1.7). The combined higher feed, forage, and grazing rent has increased total feed cost per cow for Kansas cow-calf producers to a record level in 2007 (Figure 1.8).

Figure 1.7 Bluestem Pasture Rental Rates for Spring Cow-calf Pairs, 1978-2008.

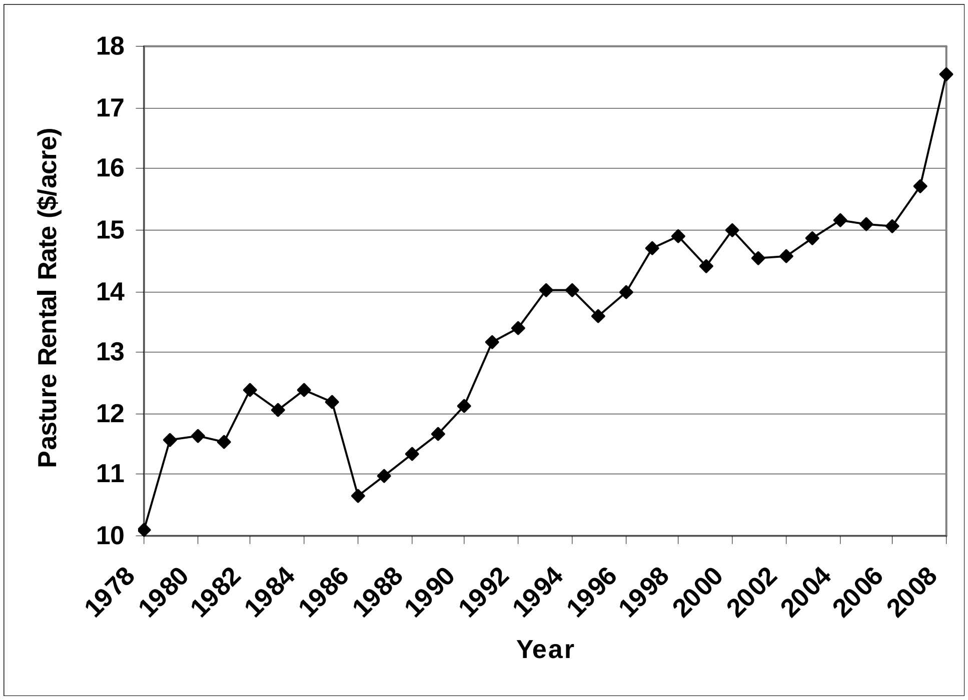
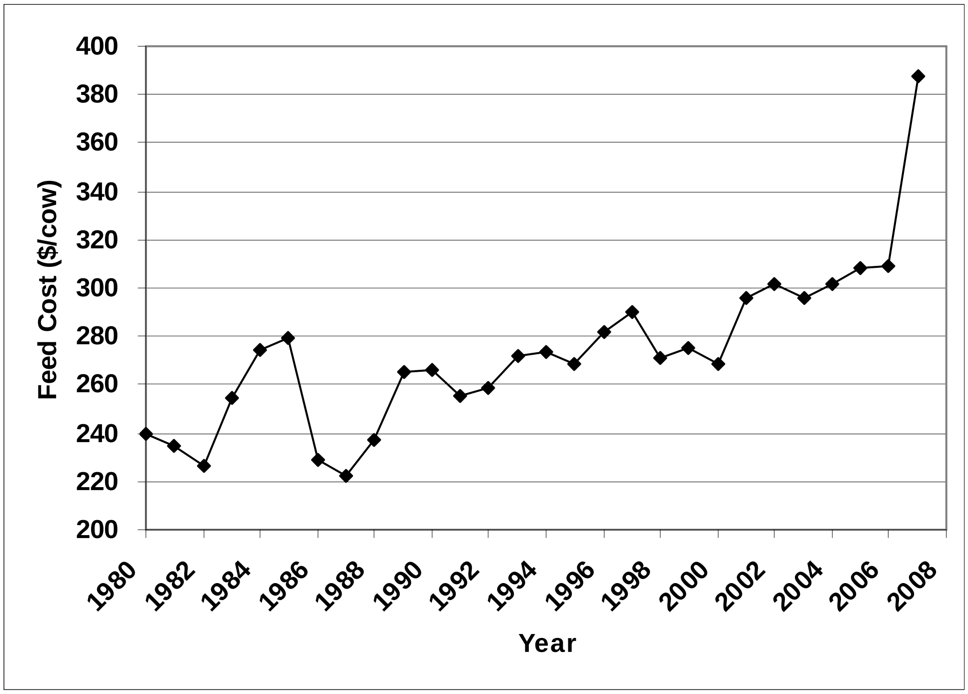


Figure 1.8 Feed Cost per Cow from Kansas Farm Management Association (KFMA), 1980-2007.



As with all economic sectors, cow-calf producers have been impacted by high oil prices. From 1996 through 2005, U.S. cow-calf producers paid an average of $25.08 per cow for energy-related inputs (ERS, 2008b). In 2006, these costs rose to $52.30, an increase of 209%. Based on enterprise data from KFMA, Kansas producers have had similar increases in gas, fuel, and oil costs per cow since 1980 (Figure 1.9). For many cow-calf production enterprises there is little that can be done to reduce their fuel expense. Figure 1.10 illustrates the recent increase in U.S. bulk diesel fuel prices that have been observed over the last three years.

Figure 1.9 Gas, Fuel, and Oil Costs per Cow from Kansas Farm Management Association (KFMA), 1980-2007.

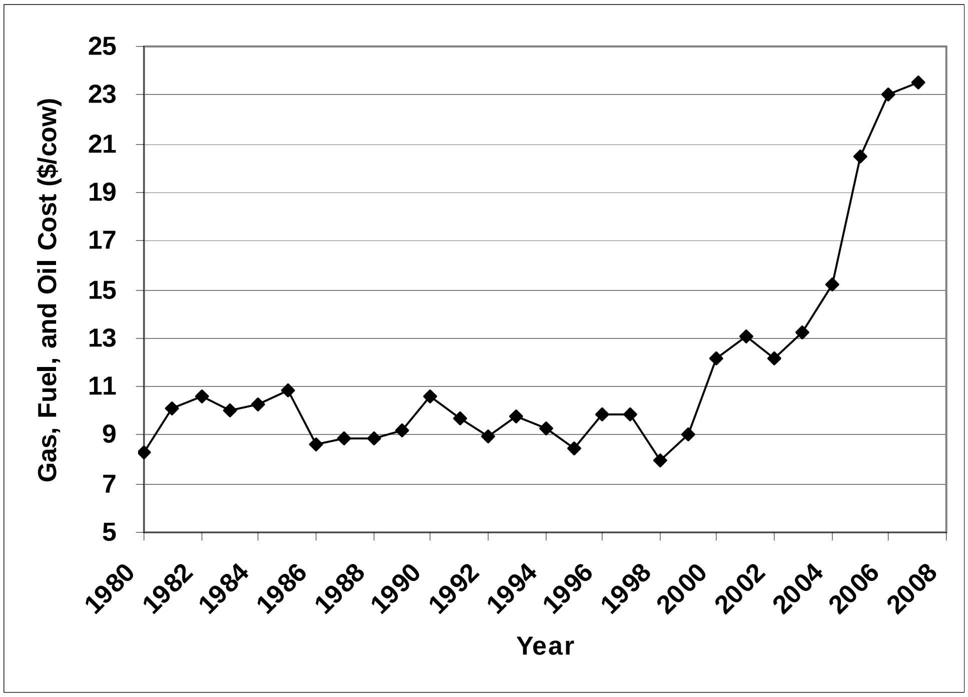
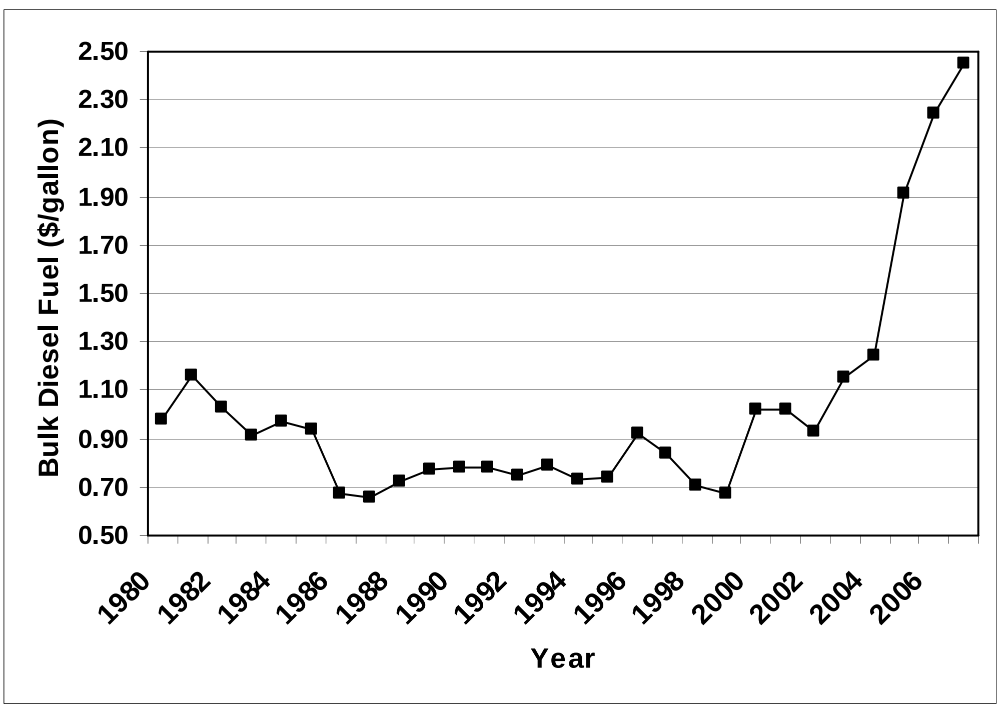


Figure 1.10 Northern Plains Bulk Diesel Fuel Price, NASS, 1980-2007.



1.3 Relationship between Ethanol Production and Cow-Calf Returns

Although ethanol cannot be tied directly to cow-calf production costs, and corn is not a major feedstock for cow-calf producers, the record level price of corn is likely impacting producer profitability. Past research has generally focused on the price of corn and its relationship to cattle finishing profitability, specifically on cattle feeding cost of gain. Historical feedlot closeout summaries collected from a western Kansas commercial feedlot from 1980 to 1989 indicated that 22% of cattle feeding profits were related to the price of corn (Langemeier, Schroeder, and Mintert, 1992). Fed and feeder cattle prices were the largest contributors to cattle profitability at the feedlot level, but corn price was also a significant contributor to profitability (Mark, Schroeder, and Jones, 2000). When cattle performance and corn price were evaluated for their relative impact on cost-of-gain, corn price was responsible for more than 60% of variability (Albright, Schroeder, and Langemeier, 1994). A study conducted by Informa Economics (2007) concluded that because there were many supply chain participants involved in the movement of cattle from the cow-calf sector through growing and backgrounding to the finishing phase, a very weak correlation is seen between corn price and fed cattle price, even when corn price was lagged to allow for the corn purchased in one period to be fed to cattle in the subsequent period. These previous studies evaluated corn price as a determinant of cattle feeding profitability at the feedlot level where corn is consumed, however these studies found cattle price affected profitability more than corn price, partly because corn could be substituted with other feed grains to reduce the cost of feed. These studies were also conducted during time periods when corn price never rose above $3.00 per bushel for more than one marketing year, unlike what has occurred since 2006. The new paradigm of sustained higher corn prices occurring simultaneously with high prices for all feedstuffs will likely strengthen the negative relationship between corn price and feeder cattle price, as research has shown that fed cattle prices do not respond to corn price changes. Increases in feed costs with no proportional increase in fed cattle prices will likely cause feeders to reduce bids for calves and attempt to purchase heavier calves and stockers to reduce the amount of grain feeding required in order to maintain profits due to the higher feed expenses.

Reduced bidding and higher input prices will directly impact the profitability of cow-calf producers.

Numerous studies have been conducted to determine the management factors that contribute the most to cow-calf producer profitability. Most research at the cow-calf level has focused on cow-calf profitability as a function of expenses and calf prices. Bruce, Torell, and Hussein (1999) concluded that yearly feed cost was the most influential factor in determining profit in cow-calf operations, which accounted for 41% of the variation, while calf price accounted for only 27%. Miller et al. (2001) concluded that variability in feed costs for a cow-calf enterprise in the Iowa/Illinois region accounted for over 50% of the variation in profit. These results are consistent with findings from research on Texas cow-calf operations (Falconer, Parker, and McGrann, 1999). The importance of managing feed costs to maintain profitability at the cow-calf level make predicting these costs especially useful for planning and budgeting in the current production environment.

1.4 Objective

Given that corn price has sustained record price levels in conjunction with major increases in expenses for cow-calf producers, the objective of this research was to determine if corn price was correlated with grazing and non-grazing feed costs for a cow-calf enterprise, and if a relationship exists between corn and cow-calf profit. If corn affects cow-calf feed expenses and profit, corn price could be used to predict future cow-calf returns.

CHAPTER II: DATA AND METHODS

2.1 Data

Past research found feed costs, including pasture rental rate and forages, are the largest variable expenses for a cow-calf producer. The ability to predict these costs for use in budgeting would allow producers to plan accordingly and adjust management practices to compensate for higher feed input prices to maintain maximum returns. Since the price of corn has seen dramatic increases and might increase more given the present government mandate for expanded ethanol production, regression analysis was performed to determine if relationships could be determined between corn price and the major cow-calf grazing and non-grazing feed inputs: grass grazing rental rate, alfalfa, and other hay. Of these feed types, only corn has a futures price associated with it. If a significant relationship exists between corn price and other feed inputs, producers could use the futures corn price to predict feed input costs at the cow-calf level and possibly predict future returns. Projecting future expenses and profit would provide producers timely information to find alternative management practices that would help sustain the viability of their operations.

Corn price data used in the analysis were monthly average nearby corn futures prices from Chicago Board of Trade (CBOT). Monthly average Kansas cash prices were also obtained from Kansas Agriculture Statistics Service for use in the grazing models. Chicago Board of Trade monthly soybean meal price was also used to determine if it could be useful in predicting forage prices.

The grass grazing rental rate in this analysis came from the Bluestem Pasture Report which is an annual report of cash rental rates for a 14-county region in the Flint Hills of eastern Kansas (KAS, 2008). The Bluestem Pasture Report is published by Kansas Agricultural Statistics Service from a producer survey of the central region of eastern Kansas. Averages from this survey are considered to be better predictors of pasture rental rates than the statewide average pasture rental rate due to the large volume of responders in the survey area. The grazing rental rate from the Flint Hills region can be used to generate grazing rates for other parts of the state by making comparisons of range and stocking rates for other regions. Annual data from 1978 through 2008 were analyzed.[1]

Alfalfa and other hay prices used in the analysis were monthly spot prices of alfalfa and other hay from January 1974 through June 2008 obtained from KAS. Alfalfa and other hay prices for the year were calculated as a simple average of the monthly spot prices for each.

Return Over Variable Costs (ROVC) was used as a measure cow-calf profitability. Feed and fuel are substantial variable input costs, and have had greater increases than other costs since 2006. Return Over Variable Cost data were collected from the Kansas Farm Management Association Cow-Calf Enterprise Analysis Reports from 1980 to 2007 (Figure 2.1). These annual reports are compiled using member data from across the state of Kansas. During the years 1980-1982 and 1993-2007, a separate Cow-Calf Report was compiled for those producers who sold calves (500-600 lb weight) and those that sold yearlings (700-800 lb weight). For those periods, a weighted average was calculated to combine the reports into one ROVC value. A major portion of ROVC is income, which can be proxied with calf selling price given that weights do not vary tremendously from year to year. The Chicago Mercantile Exchange (CME) feeder cattle futures price averaged for October through December, which is the time when most calves are sold, was used as a proxy of gross income in the analysis of estimating ROVC. As an estimate of the energy cost per cow, the analysis used bulk diesel fuel yearly average price per gallon for the northern plains as reported by the USDA National Agricultural Statistics Service for the period 1980-2007. A list of the dependent and independent variables used in this analysis along with their corresponding summary statistics are shown in Table 2.1. Available data were used to determine the impact of corn price on specified feed inputs and ROVC during those years within the sample periods, and to forecast prices and ROVC for 2008 and 2009.

[1] KAS did not conduct surveys in 1987, 1988, or 2005. These three years were "filled in" using weighted averages of the surrounding years. Averages values for 1987 were calculated using weights of 0.67 and 0.33 to 1986 and 1989 reported values, respectively. The weights were reversed when calculating values for 1988. A simple average of reported values for 2004 and 2006 was used for 2005.

Figure 2.1 Cow-Calf Returns over Variable Costs, KFMA, 1980-2007.

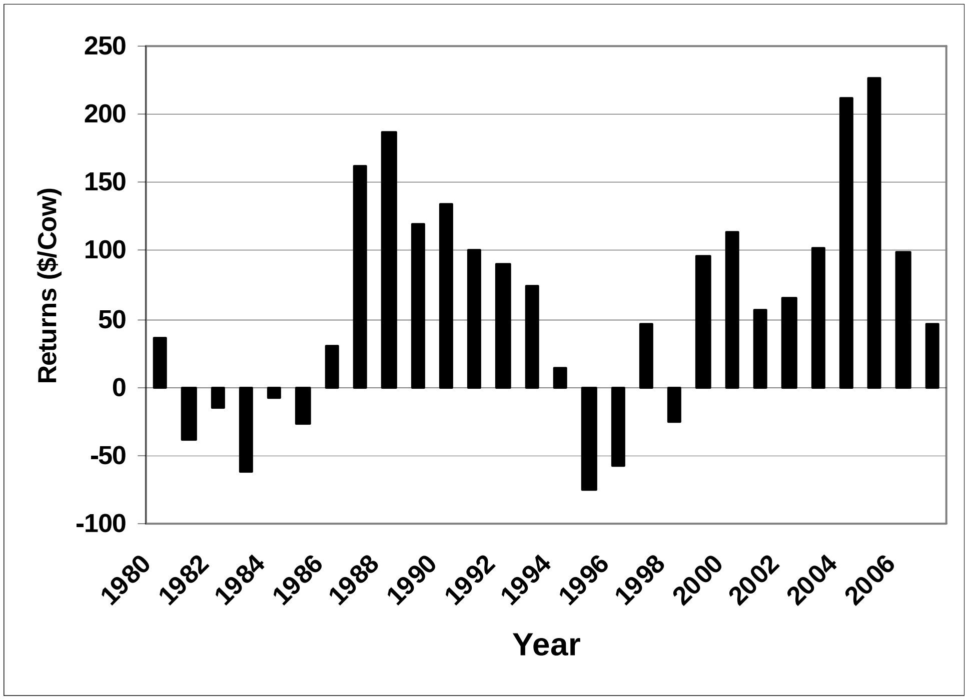


Table 2.1 Variable Summary Statistics.

Variable	Period	Unit	Mean	Std. Dev.	Minimum	Maximum	N
GGRR[1]	1978-2008	$/acre	$13.37	1.77	$10.09	$17.54	30
CBOT J-M JULY CN[2]	1978-2008	$/bu	$2.77	0.72	$1.64	$5.38	30
KAS J-M CASH CN[3]	1978-2008	$/bu	$2.53	0.65	$1.54	$4.77	30
KFMA ROVC[4]	1980-2007	$/cow	$60.73	82.25	($75.82)	$227.05	27
CME FC[5]	1980-2007	$/cwt	$81.07	14.72	$62.00	$115.60	27
CBOT CN AA[6]	1980-2007	$/bu	$2.59	0.49	$1.73	$3.76	27
KAS ALF[7]	1980-2007	$/ton	$73.00	14.82	$43.67	$112.08	27
KAS HAY[8]	1980-2007	$/ton	$54.76	9.26	$38.67	$73.75	27
NASS DS FUEL[9]	1980-2007	$/gal	$1.02	0.45	0.66	2.447	27
CBOT SBM MA[10]	1974-2008	$/ton	$186.90	42.40	$106.30	$396.36	413
CBOT CN MA[11]	1974-2008	$/bu	$2.65	0.66	$1.50	$6.99	413
KAS ALF MA[12]	1974-2008	$/ton	$70.63	18.36	$35.00	$125.00	413
KAS HAY MA[13]	1974-2008	$/ton	$53.81	11.51	$32.87	$88.00	413

[1]Grass Grazing Rental Rate, KAS Bluestem Report, spring cow-calf pairs
[2]CBOT July corn futures contract price, January through March average
[3]KAS cash corn price, January through March average
[4]KFMA Returns Over Variable Costs
[5]CME nearby feeder cattle futures contract price, October through December average
[6]CBOT nearby corn futures prices, annual average
[7]KAS annual average alfalfa price
[8]KAS annual average other hay price
[9]NASS annual average diesel fuel price for Northern Plains
[10]CBOT nearby soybean meal futures contract price, monthly average
[11]CBOT nearby corn futures contract price, monthly average
[12]KAS alfalfa price, monthly average
[13]KAS other hay price, monthly average

2.2 Models Specified

A regression analysis was performed to determine if there was a relationship between corn price (CN) and grass grazing rental rates (GGRR). Because an alternative to grazing is to feed cattle concentrates, it was hypothesized that corn price would be significantly correlated with grass grazing rental rate. Two models were estimated, the first using the KAS average cash price for corn in Kansas for January, February, and March for each year (KAS J-M CASH CN). The regional spot price between January and March for corn is considered to coincide roughly with the time most grass grazing rental rates are set. This model is expressed as:

(1) GGRR = f(KAS J-M CASH CN).

The second model used the average of the CBOT July corn futures contract price as reported in January, February, and March for each year (CBOT J-M JULY CN). The July corn futures contract price for January through March might be used to predict the price of grazing alternatives during the middle of the grazing season for spring cow-calf pairs. This model was expressed as:

(2) GGRR = f(CBOT J-M JULY CN).

Each model was evaluated to determine if corn price can predict grass grazing rate, and if so, whether the futures or cash corn price should be used to establish grass grazing rental rates in the spring of each year.

Two more models were estimated that also included year as an independent variable with corn price since previous research showed grazing rate trends upward over time (Dhuyvetter, Berns, and Kastens, 2006). These models were expressed as follows:

(3) GGRR = f(KAS J-M CASH CN, YEAR), and

(4) GGRR = f(CBOT J-M JULY CN, YEAR).

Regression analysis was performed to determine if there was a relationship between the harvested forages alfalfa hay price (KAS ALF MA) or other hay price (KAS HAY MA) with either corn or soybean meal price. The corn (CBOT CN MA) and soybean meal (CBOT SBM MA) prices used were the CBOT monthly nearby futures prices. Corn and soybean meal price were expected to be correlated with alfalfa price and other hay price since they could be used as substitutes in a feeding program. The model included year as an independent variable since hay prices have increased with time. Soybean meal was expected to be a better predictor of alfalfa price than corn since it is considered to be a protein supplement like alfalfa, while corn is considered to be an energy concentrate. Similar results were expected for the correlation of corn and soybean meal prices with the price of other hay. These models were expressed as:

(5) KAS ALF MA= f(CBOT CN MA, YEAR),

(6) KAS ALF MA – f(CBOT SBM MA, YEAR),

(7) KAS HAY MA – f(CBOT CN MA, YEAR), and

(8) KAS HAY MA – f(CBOT SBM MA, YEAR).

Several ordinary least squares (OLS) regression models were used to estimate Returns Over Variable Costs (KFMA ROVC) for cow-calf operations using grass grazing rental rate, alfalfa, other hay, diesel fuel, corn, and feeder cattle prices. It was expected that corn price could be used in the model to replace the other feeds, alfalfa, other hay, and grass grazing rental rate, and be a feed ingredient which had a futures price associated with it. Knowing the futures feed price allows for predicting what the future ROVC might be. All regression models for ROVC included diesel price (NASS DS FUEL) and the CME October through December futures contract price of feeder cattle (CME FC). Models compared corn (CBOT CN AA), alfalfa (KAS ALF), and other hay (KAS HAY) as different harvestable feed variables along with grass grazing rental rate (GGRR) as a non-harvested feed variable, and using corn only in the model and not including grass grazing rental rate. The models to estimate were expressed as:

(9) KFMA ROVC = f(CME FC, NASS DS FUEL, CBOT CN AA),

(10) KFMA ROVC = f(CME FC, NASS DS FUEL, GGRR),

(11) KFMA ROVC =f (CME FC, NASS DS FUEL, GGRR, CBOT CN AA),

(12) KFMA ROVC =f (CME FC, NASS DS FUEL, GGRR, KAS ALF), and

(13) KFMA ROVC = f(CME FC, NASS DS FUEL, GGRR, KAS HAY).

Although many other expenses and some income variables could be included in a full enterprise analysis, these input costs were selected since feed and energy costs have increased the most dramatically and are expected to continue to increase in the near future.

Models predicted in equations 9-13, with all variables in linear form, were estimated with linear regression using Minitab 15 statistical software to determine the best predictor of ROVC (Minitab, 2008).

CHAPTER III: RESULTS AND DISCUSSION

From 1978 through 2007, neither cash or futures corn prices were statistically significant in explaining variation in grass grazing rental rate (Table 3.1). When 2008 data were included, cash corn price explained 10% and futures corn price explained 12% of the variation in grass grazing rental rate (Table 3.2). Both the January through March average Kansas cash corn price and the January through March average CBOT July corn futures price explained about the same amount of variation in grass grazing rental rate (Tables 3.1 and 3.2). Year alone explained 84% of the variation in grass grazing rental rate (Table 3.3). Grass grazing rental rate increased an average of $0.18/acre per year between 1978 and 2008 (Table 3.3). Year and cash corn price from 1978 through 2008 explained 88%, and year and futures corn price from 1978 through 2008 explained 89% of the variability in grass grazing rental rate (Table 3.3). Prior to 2008 corn price had no affect on grass grazing rental rate within this data set, but the recent record high corn and alternative feed prices appears to have now developed a relationship between corn price and grass grazing rental rate. Had grazing rate data been available going further back in history than 1978, a relationship between corn price and grazing rate may be observed. One factor may be that there has not been enough variation in corn price between 1978 and 2007 to see a statistically significant relationship. As previously mentioned, cattle feeders historically were able to use alternative feed grains when a particular commodity price was high. These results suggest cattle feeders and possibly cow-calf producers are currently utilizing pasture grazing to put gain on cattle more than in the past due to the high cost of feed grains. This would support the hypothesis that within the sample analyzed, and provided corn prices remain at elevated levels compared to their long term average, a strengthening relationship between corn price and grazing rate will be observed. This would indicate producers can improve their forecast of grass grazing rental rate by including corn futures price with a linear time trend, allowing a more accurate prediction of grazing costs for the coming years.

Table 3.1 Regression Results, Predicting Grazing Rates, 1978-2007.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 1			
KAS J-M CASH CN	0.3477	0.5959	0.564
R^2	0.0%		
RMSE	1.6319		
Observations	29		
Equation 2			
CBOT J-M JULY CN	0.4030	0.5648	0.481
R^2	0.0%		
RMSE	1.6270		
Observations	29		

Table 3.2 Regression Results, Predicting Grazing Rates, 1978-2008.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 1			
KAS J-M CASH CN	0.9671	0.4714	0.049
R^2	9.7%		
RMSE	1.6778		
Observations	30		
Equation 2			
CBOT J-M JULY CN	0.9515	0.4225	0.032
R^2	11.9%		
RMSE	1.6562		
Observations	30		

Table 3.3 Regression Results, Predicting Grazing Rates, 1978-2008.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 3			
KAS J-M CASH CN	0.5776	0.1733	<0.01
YEAR	0.17177	0.01239	<0.01
R^2	88.1%		
RMSE	0.6083		
Observations	30		
Equation 4			
CBOT J-M JULY CN	0.5606	0.1535	<0.01
YEAR	0.17050	0.01209	<0.01
R^2	88.8%		
RMSE	0.5916		
Observations	30		
YEAR	0.17846	0.01419	<0.01
R^2	84.0%		
RMSE	0.7071		
Observations	30		

Monthly nearby corn and soybean meal futures prices were significantly correlated to monthly alfalfa price, although corn price unexpectedly explained 5% more of the variability in alfalfa hay price than soybean meal price (Table 3.4). Combined with year, corn price explained 71% and soybean meal explained 66% of the variability in alfalfa hay price. It was hypothesized that soybean meal would be a better predictor of alfalfa price than corn because soybean meal and alfalfa are both protein sources in the diet, whereas corn is considered to be an energy source. Corn has historically been produced primarily for animal feed and thus its price has been heavily influenced by domestic and international demand for feed. The price of corn might be more correlated to the price of other feeds such as alfalfa and other hay because corn is more directly tied to the livestock feeding industry by its use as a direct feed ingredient. Soybean meal is a by-product of crushing soybeans for oil, and the price of soybeans might be more influenced by world demand for soybean oil used for human food and biofuel than as a protein source for livestock, similar to cottonseed meal, a by-product of cotton grown for fiber, being used as a protein source in rations. Corn and soybean meal prices were not as correlated to the price of other hay as they were to alfalfa. When combined with year, corn price explained 63% and soybean meal price explained 54% of the variability in other hay price (Table 3.5). Alfalfa hay price was more correlated to the price of other hay than corn or soybean meal, explaining 81% of the variability in other hay price (Table 3.5). This is because alfalfa and other hay share similar production environments and can often be substituted for one another in some livestock rations and feeding programs. However, alfalfa and other hay prices do not have a futures price associated with them like corn or soybean meal and thus are not as readily available to estimate future feed costs. Interestingly, year was significantly correlated to alfalfa and other hay price, explaining 60% of the variability in alfalfa price and 47% of the variability in other hay price. Year was not significantly correlated to corn price between 1974 to mid 2008 (Table 3.6). Between 1974 and 2008 alfalfa price increased an average of $1.42/ton per year and other hay increased an average of $0.79/ton per year (Table 3.6).

Corn price explained 11% of the variability in alfalfa hay prices (Table 3.4). The significant relationship between corn price and ethanol production makes ethanol production an indirect contributing factor in the price of alfalfa and other hay. The impact of ethanol production on forages might be even greater in the future as recent research indicates that more roughage or forages need to be fed in a finishing cattle ration that uses distiller's grains, which are the byproduct of starch-based ethanol production (Drouillard, 2008).

Table 3.4 Regression Results, Predicting Alfalfa Hay Price, 1974-2008.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 5			
CBOT CN MA	9.4226	0.7335	<0.01
YEAR	1.42669	0.04862	<0.01
R^2	71.2%		
RMSE	9.8489		
Observations	413		
Equation 6			
CBOT SBM MA	0.11708	0.01284	<0.01
YEAR	1.28719	0.05461	<0.01
R^2	66.4%		
RMSE	10.6301		
Observations	413		

Table 3.5 Regression Results, Predicting Other Hay Price, 1974-2008.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 7			
CBOT CN MA	6.9639	0.5225	<0.01
YEAR	0.79246	0.03463	<0.01
R^2	62.8%		
RMSE	7.0000		
Observations	413		
Equation 8			
CBOT SBM MA	0.075147	0.009439	<0.01
YEAR	0.70269	0.04013	<0.01
R^2	53.8%		
RMSE	7.8102		
Observations	413		
KAS ALF MA	0.56457	0.01339	0.000
R^2	81.1%		
RMSE	8.0000		
Observations	413		

Table 3.6 Regression Results, Predicting Corn, Alfalfa, Other Hay Price, 1974-2008.

Variable	*Coefficient*	*Std Err*	*P-value*
Corn Price			
YEAR	-0.000258	0.003265	0.937
R^2	0.0%		
RMSE	0.6619		
Observations	413		
Alfalfa Price			
YEAR	1.42426	0.05749	<0.01
R^2	59.7%		
RMSE	11.6620		
Observations	413		
Other Hay Price			
YEAR	0.790665	0.041393	<0.01
R^2	46.8%		
RMSE	8.3897		
Observations	413		

Several models were evaluated using bulk diesel fuel price, feeder calf price, corn price, alfalfa price, other hay price, and grass grazing rental rate to estimate Kansas cow-calf producer Returns Over Variable Costs (ROVC). The independent cost variables diesel fuel, grass grazing rental rate, corn, alfalfa, and other hay price all had the expected negative affect on ROVC, and the independent income variable feeder calf price had the expected positive affect on ROVC, and all independent variables were statistically significant at $P \leq 0.05$ (Table 3.7).

Models that included diesel fuel, feeder calf, grazing rent, and one of the harvested feeds (corn, alfalfa, or other hay) price explained 91% of the variability in ROVC (Table 3.7). Including more than one of the harvestable feed types in the same model resulted in the harvestable feed variables being insignificant in the model, suggesting correlation between the three feed types (data not shown). These results indicate that any of these harvestable feeds can be used to estimate ROVC. However, of these harvestable feeds, only corn has a futures price, making it a more appropriate variable to add to the model for predicting future ROVC. A model that included diesel fuel, feeder calf, and corn prices explained 79% of the variability in ROVC, and replacing corn with grazing rent in the model explained 89% of the variability in ROVC (Table 3.7). Including grazing rent in the model with corn price increased the amount of ROVC variability explained because corn price explained very little variability in grazing rent (Table 3.1). While cow-calf producers use little corn directly in their operations, this research shows that corn price is an important determinant of cow-calf production returns, and corn price can be used by producers to plan for future rising production costs in order to maximize returns.

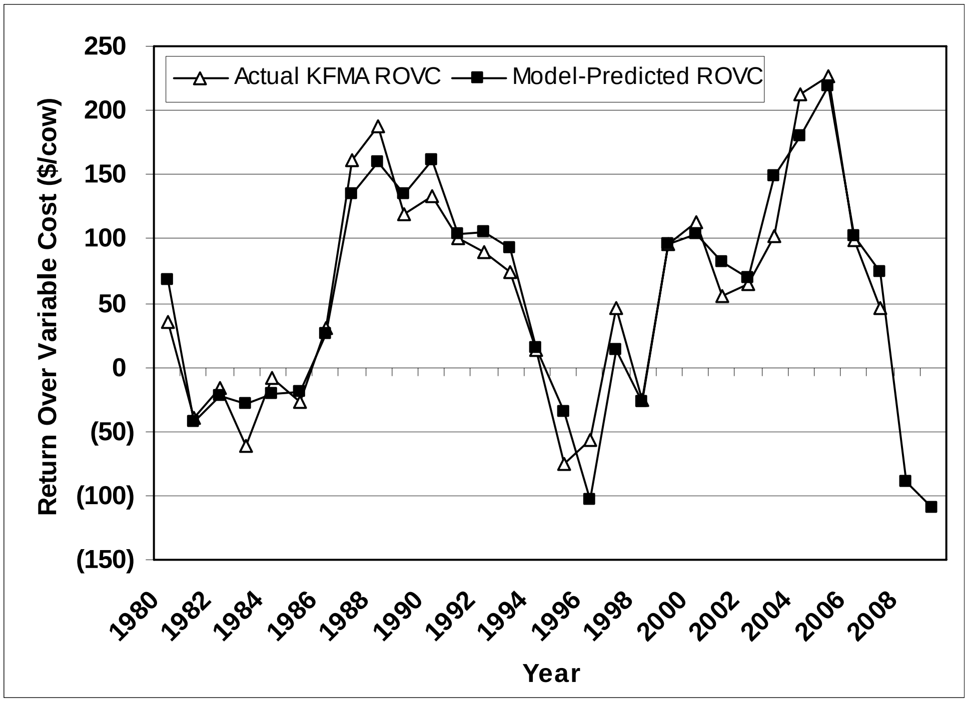
Although negative and significant as expected, the marginal effect of a change in diesel fuel price in all ROVC models appears to be exaggerated. Depending on the model used, a one-unit change in diesel fuel price results in a change in ROVC ranging from $67 to $98 per cow. The high end of the realistically expected value would be in the range of $25 to $30 per cow when using diesel fuel as a proxy for all energy costs incurred by a cow-calf operation (Dhuyvetter and Jones, personal communication, 2008). This unusual result could be a consequence of multicollinearity between the independent variables used, and due to the relatively small data set analyzed. Furthermore, due to the range of diesel fuel price data, a one-unit change in diesel fuel price is a substantial change within the data sample analyzed, which exhibited a range of $0.66 to $2.47 per gallon, or only $1.81 between minimum and maximum value (Table 2.1). It is expected that diesel fuel price has a significant impact on ROVC, but its impact appears to be overstated in these models. Its inclusion does improve the amount of variability in ROVC that is explained by the models, and as more data become available, the coefficients of all variables will become more precise.

Table 3.7 Regression Results, Predicting ROVC, 1980-2007.

Variable	*Coefficient*	*Std Err*	*P-value*
Equation 9			
CME FC	5.5547	0.8100	<0.01
NASS DS FUEL	-73.44	27.6944	0.0140
CBOT CN AA	-41.0281	19.1694	0.0427
R^2	78.6%		
RMSE	38.0375		
Observations	27		
Equation 10			
CME FC	7.8586	0.5500	<0.01
NASS DS FUEL	-97.68	16.17	<0.01
GGRR	-24.759	4.537	<0.01
R^2	88.6%		
RMSE	27.7300		
Observations	27		
Equation 11			
CME FC	6.9776	0.5666	<0.01
NASS DS FUEL	-66.6975	17.6469	<0.01
GGRR	-23.9239	3.9682	<0.01
CBOT CN AA	-35.7198	12.2220	<0.01
R^2	91.4%		
RMSE	24.1889		
Observations	27		
Equation 12			
CME FC	7.7826	0.4868	<0.01
NASS DS FUEL	-91.90	14.44	<0.01
GGRR	-16.162	5.063	<0.01
KAS ALF	-1.2839	0.4616	0.011
R^2	91.1%		
RMSE	24.4949		
Observations	27		
Equation 13			
CME FC	7.5245	0.5214	<0.01
NASS DS FUEL	-93.74	14.87	<0.01
GGRR	-15.23	5.741	0.014
KAS HAY	-1.8648	0.7772	0.025
R^2	90.5%		
RMSE	25.3377		
Observations	27		

The model using feeder cattle price, diesel fuel price, grass grazing rental rate, and corn price explained the most variability in ROVC, and was used to test the model's correlation to producer KFMA ROVC reported from 1980 to 2007. The ROVC model correlated well with actual KFMA ROVC with a mean error of $18.43/cow, and a standard deviation of the mean error of $14.63. Figure 3.1 shows actual KFMA data and the model-predicted ROVC for 1980 to 2009. Only the predicted ROVC for 2008 and 2009 is shown in Figure 3.1 since KFMA data are not yet available. The ROVC model for 2008 used the October feeder cattle contract price of $114.00/cwt, as reported in July, a southwest Kansas July diesel fuel spot price of $3.54/gallon, a southwest Kansas July corn spot price of $5.76/bu, and a grass grazing rental rate of $17.54/acre, as reported by the Bluestem Report. With these data, the ROVC model predicted that cow-calf producers will lose $90/cow in 2008, and a sensitivity analysis indicated that feeder cattle prices would have to reach $126.90/cwt, or corn would need to fall to $3.24/bu for ROVC to breakeven given these costs. Using the 2009 average feeder cattle futures contract price of $98.97, the 2009 average corn futures price of $4.50, a forecasted diesel price of $3.47, and a grazing rental rate of $16.05/ac (calculated using Equation 4), the model predicts producers will lose $110/cow. The results of this model corroborate cost increases identified for cow-calf producers in the fall of 2007 (Dhuyvetter and Kastens, 2007). The breakeven cost for cow-calf producers increased 19%, feed costs increased 46%, and total cost/head/day increased 23% for the fall of 2007 compared to the average from 1997 to 2006. A predicted loss of $90-110/cow by the ROVC model for 2008 and 2009 would be the largest loss per cow in the past 28 years.

Figure 3.1 Model-Predicted and Actual Return Over Variable Cost (ROVC), 1980-2009.



In summary, the results of this analysis found corn price can be used to predict the price of alfalfa and other hay, and the ROVC for cow-calf producers. Historically, corn price was not related to grass grazing rental rate in a statistically significant way. However recently rising corn prices appear to be related to increasing grass grazing rental rates. Corn has a futures price associated with it unlike grazing rent, alfalfa, and other hay, therefore making corn price useful in predicting the future prices of alfalfa, other hay, and grazing rent. A model estimated using feeder cattle, diesel fuel, and corn prices along with grass grazing rental rates explained 91% of the variability in ROVC. A feeder cattle futures price, a corn futures price, a forecasted diesel fuel price, and a model-predicted grazing rental rate can be used in the ROVC model to help producers predict future ROVC, construct budgets, and assist with planning for the future financial stability of their operations. This model will allow producers to identify management strategies for their operations that will maintain acceptable ROVC in the future.

It is likely that corn prices will remain high and might even increase as long as ethanol production continues at its present level or increases, as is currently mandated by the federal government. The current feeder cattle market and consumer beef demand coupled with high corn prices, indicate cow-calf producers should plan for no significant increases in calf or feeder prices and the likelihood of continued increasing costs of gain for the next couple of years. Some alleviation in feed costs might come from distiller's grains, but incorporating that feed ingredient at the cow-calf level might be difficult and not necessarily cost effective for all producers. An intense focus on efficiency and cost management at all levels of production will be vital to maximize returns and ensure the viability of cow-calf operations.

Due to the limitations of the data used for this analysis, i.e., having only 28 observations for ROVC, future research is needed to continue to analyze the relationship between corn price and cow-calf costs and returns. Another factor that should be evaluated further is the magnitude of the relationship between diesel fuel and ROVC. As energy prices have become a substantial input cost, measuring the true impact on cow-calf profitability becomes more important. Provided the present mandates are maintained, corn use in ethanol will continue to impact corn prices and exert market competition on the livestock industry. As more data become available, the accuracy of the model can be re-evaluated in using corn price to predict cow-calf input costs and ROVC.

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